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SURFACE MINING EMISSION STUDY
FINAL REPORT

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FINAL REPORT

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Submitted to

ROCKY MOUNTAIN FOREST
AND RANGE EXPERIMENT STATION

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by

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FINAL REPORT

SURFACE MINE EMISSION STUDY

INTRODUCTION

Over the past decade, the United States has become more and more dependent upon coal as one of its primary energy sources. Of the 3,986,300 million tons of coal available in the U.S., approximately one third is on lands managed by the Federal Government. Much of this federally owned coal is located in the Rocky Mountain iegion. The Federal Coal Management Program, administered by the Secretary of the Interior, charged with the leasing of these coal reserves, has been responsible for the continued evaluation of the potential environmental effects, particularly air quality, in the leasing and development of these western energy resources. Unfortunately, environmentally sound coal lease management decisions are often limited by: (a) frequently changing and often confusing regulatory directives by the Environmental Protection Agency, (b) a lack of knowledge about the baseline atmospheric conditions in the lease areas, particularly those in regions of complex terrain, and (c) limitations in our knowledge of the magnitude of the effects of mining activities on the local and regional air quality.

The Surface Mine Emission Study, a cooperative research project between the Air Resource Program, Department of Earth Resources, Colorado State University and the Mountain Meteorology program of the Rocky Mountain Forest and Range Experiment Station of the USFS, was a five year effort to assist the Bureau of Land

Management in determining the impact of certain federal activities such as coal leasing and oil shale leasing programs, on the air quality.

The research was conducted as a number of interrelated activities, combining a series of field measurement programs with development of new modeling techniques with the goal of developing basic understanding of the influences of western surface coal mining on the atmospheric environment. A major emphasis was placed on the development of new numerical modeling methodology for prediction of transport and diffusion of gaseous and particulate pollutants from existing and proposed sources, the locations of areas with high pollution potential due to air stagnation, and the magnitude of the projected air quality deterioration in the stagnation areas downwind from the projected lease sites.

SUMMARY OF SELECTED IMPORTANT RESULTS OF RESEARCH PROGRAM

o FIELD PROGRAMS

-Coal Mine Emission Studies: The primary air quality problem associated with coal surface mines was found to be the fugitive dust particulates. The goal of the research efforts in this area was to provide new information on the nature and magnitude of air quality impacts of different surface mine sources of fugitive particulates as they influence the management and leasing practices of coal lands under federal agency jurisdiction. A comprehensive field study was conducted at a large strip mine near Craig, Colorado to investigate the sources, quantities, and physical-chemical nature of mine emissions. Data on the total mass, size distribution, threshold wind velocity, and particulate trajectory and deposition patterns

were obtained during three measurement periods within three different seasons for fugitive emissions from the mine, topsoil and overburden removal activities, open storage piles, and a coal crushing operation.

The field measurement program was a joint cooperataive effort involving personnel fro the USFS-RMFRES, the BLM, CSU, Utah International Coal Co., The National Center for Atmospheric Research, Denver Research Institute, and the Univ. of Minn. Measurements included micrometeorological towers, hi-vol samplers, deposition plates, thimble filters, a tethersonde meteorological package, a tethersonde particulate sampler, and a portable wind tunnel.

Results of the field study were reported in a number of progress reports and five comprehensive technical papers. These and all other publications prepared under this cooperative agreement were submitted to the RMFRES. Copies are on file in the Mountain Meteorology Project Office of the USFS. A listing of titles, authors, dates, etc., for bibliographical record is provided in the appendix to this final report. (Appendix A.)

-Atmospheric Visibility Monitoring Program: Since visibility measurement technology was still in a developing research stage, no instrumentation had yet been standardized as of the time of this project. Two visibility monitoring instruments were installed on the hill just above the town of Craig, Colorado. The first was an integrating nephelometer which measures the scattering of light by particles passing through an optical chamber within the instrument. Thus is is a measure of the local area visibility assuming that the concentration of light scattering particles is uniformly distributed over the region. The second instrument was a manually operated multi-wavelength telephotometer which measures apparent spectral radiance and the ratio of target to sky (background) spectral radiance of four separate targets at four separate wavelengths.

The visibility measurements made at Craig, Colorado were compared to measurements made at Dinosaur National Monument. Results of this comparison indicated that the visibililty in the Yampa river valley is, on the average, somewhat lower due to mining, agriculture and other activities in the area. The Craig Office of the Bureau of Land Management is continuing the visibility monitoring programs to obtain a baseline of data for the Craig airshed. It is anticipated that these data will prove to be of considerable usefulness to the coal lease program office.

-Atmospheric Deposition Monitoring Program: In cooperation with the Craig, Colorado District Office of the Bureau of Land Management, an atmospheric monitoring station was installed at a location on Sand Spring approximately five miles west of Craig (40° 30', 107° 42'). The station was placed in operation in March, 1979 and has been integrated into the National Atmospheric Deposition Program (NADP). The NADP is a nationwide project organized to assess both the composition and amount of chemical deposition and their effects on the nation's agriculture, forests, rangelands and freshwater streams and lakes.

The operation of the Sand Spring station is now under the direction of the Craig BLM office. It is expected that data collected at this station over the next decade will provide valuable information not only on the acidity of the precipitation of northwestern Colorado, but a number of airborne constituents for rangeland managers of the future.

o COMPUTER MODELING PROGRAMS

-Development of the TAPAS model: A major accomplishment of the project was the development of the TAPAS (Topographic Air Pollution Analysis System) computer model designed for use in estimating the trajectory and dispersion of plumes moving over areas of complex terrain. In order to predict concentrations in complex topography it is necessary to: (a) estimate the meteorology of the region in some detail, (b) estimate the diffusion of pollutants (c) estimate the removal and/or chemical transformations of the pollutants. The TAPAS model consists of sets of procedures to accomplish this task.

The fundamental TAPAS model consists of a number of sub modules used for different applications in air quality analysis. Major emphasis was placed on combining the WINDS model, a two-dimensional complex flow model which provides an analysis capability to calculate the distribution of near-surface wind speed and direction over a grid based upon an assumed (or measured) background wind, with CITPUFF, a Lagrangian "puff" - diffusion model. Dr. G. Ross, Chairman of the Department of Applied mathematics, Caufield Institute of Technology, Melbourne, Australia and author of the CITPUFF model spend a portion of one year with the Surface Mine Emission Study project to integrate the WINDS and CITPUFF models into TAPAS.

The principle investigators worked closely with the Bureau of Land Management air quality specialists in the area of TAPAS model development to review approaches currently used by the agency in their analyses of coal leasing impacts, their experiences to date in modeling and their requirements for future modeling efforts. The TAPAS model was expanded to become a menu driven library of interactive computer models for quanitative evaluation of air quality suitability for coal and other energy leasing programs.

Users manuals were written for the TAPAS model and provided to key individuals in the Forest Service and Bureau of Land Management. A workshop/training program was conducted to provide training for the most appropriate individuals.

-Stagnation Potential Studies of Northwestern Colorado: The WINDS model component of TAPAS was used very successfully to develop maps of wind fields and stagnation patterns over energy resource area of northwestern Colorado. When coupled with transparency overlays of locations of current mining activities, power plants and other sources, plus overlay maps of existing and proposed new lease tracts, air quality considerations could be incorporated into the procedures for establishing new coal leases. Results of this efforts were summarized in a report " Energy Development Planning and Air Quality: A Modeling Assessment of Northwestern Colo." and a copy of this report was delivered to the Coal Program Office of the Bureau of Land Management.

-Air Quality Impact Assessment for Federal Oil Shale Program: At the request of the Bureau of Land Management, the TAPAS model was used to determine areas of poor dispersion meteorology within the oil shale regions of Colrado, Utah and Wyoming. Results of these studies were used for the siting of meteorological monitoring stations, for environmental assessments, and for land use planning activities associated with proposed development of oil shale lease tracts.

The TAPAS model was also used as a major tool in the air quality impact assessment for both the Federal oil shale prototype lease and the Federal oil shale management program. Results from these studies formed the basis of the air quality components of the environmental impact statements for the prototype lease and the management program.

APPENDIX A

REPORTS AND PUBLICATIONS

During the five years of the Surface Mine Emission Study, a large number of progress reports, subcontractor reports, maps, data banks and technical publications were prepared. The most important of the research results were summarized and presented at workshops, conferences, and meetings of angecies and professional societies. Several technical articles were prepared as were technical reports which accompanied the Bureau's draft and final environmental impact statements.

Since these reports comprise literally tens of thousands of pages, no attempt is made to include them in this final report. All were submitted either to the Mountain Meteorology Project Office of the RMFRES or through that office to the Bureau of Land Management. Copies of all reports and publications should be available from the RMFRES.

Bibliographical information on some of the more important documents generated by the projects are given below:

- Marlatt, W. E., Preliminary Results: Surface Mine Emission Study, July 30, 1979 - Aug. 7, 1979. Sept. 25, 1979.
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- Zeller, K. F., D. G. Fox, and W. E. Marlatt, Estimating Dust Production from Surface Mining. Paper presented at _____meeting. Fall, 1979.
- Armstrong J. A., P. A. Russell, and D. C. Drehmel, Particle Production from Surface Mining: Part 1, Vertical Measurements. Procedings of Fourth Symposium on Fugitive Emissions: Measurements and Control. May 28-30, 1980, New Orleans, La.
- Dietrich, D. L., W. E. Marlatt, and D. G. Fox, Particle Production from Surface Mineing: Part 2, Surface Particulate and Meteorological Measurements. May 28-30, 1980, New Orleans, La.
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- Wood, M.C., D. G. Fox, and W. E. Marlatt, Energy Development Planning and Air Quality: A Modeling Assessment of Northwestern Colorado. Report to Colorado State Office, Bureau of Land Management and Procedings, of the American Meteorological Society Conference on Mountain Meteorology, Steamboat Springs, Colo. Nov. 1981.
- Childs, J. E. and W. E. Marlatt, the Topographic Air Pollution Analysis System (TAPAS) - A Guide to the System Software. Report to the Rocky Mountain Forest and Range Experiment Station, June 1981.

- Ross, D. G., D. L. Dietrich, D. G. Fox and W. E. Marlatt, CITPUFF: A Gaussian Puff Model for Estimating Pollutant Concentration in Complex Terrain. In review cycle to be published as a Station Technical Paper, RMFRES. 1982.

- Dietrich, D. L., D. G. Fox, M. C. Wood and W. E. Marlatt, Air Quality Impact Assessment for the Supplemental Environmental Impact Statement for the Prototype Oil Shale Leasing Program. Report Prepared for the Colorado State Office, Bureau of Land Management. 1982.

- Dietrich, D. L., D. G. Fox, M. C. Wood and W. E. Marlatt, Air Quality Impact Assessment for the Environmental Impact Statement on the Federal Oil Shale Management Program. Report Prepared for the Colorado State Office, Bureau of Land Management. 1982.

- Dietrich, D. L., D. G. Fox, M. C. Wood and W. E. Marlatt, Air Quality Impact Assessment for the Supplemental Impact Statement for the Prototype Oil Shale Leasing Program. Report Prepared for the Division of EIS Services, Bureau of Land Management. 1983.

- Dietrich, D. L., D. G. Fox, M. C. Wood and W. E. Marlatt, Air Quality Impact Assessment for the Environmental Impact Statement on the Federal Oil Shale Management Program. Report Prepared for the Division of EIS Services, Bureau of Land Management, 1983.

- One subcontractor technical report on the analysis of turbulence data collected at the Trapper Mine, by W. Sadeh, Department of Civil Engineering, Colo. State Univ. remains to be submitted to the RMFRES.